

**AMENDMENT TO THE CLAIMS**

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Original) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,  $t+N$  ( $N$  is a positive integer which is 1 or more) each having an equal interval are supplied and as complex Fourier coefficients under degree  $k$  ( $k$  is 0 or a positive integer smaller than  $N$ ) obtained by, with such  $N$  data values supplied since time  $t$  as a data stream, carrying out complex Fourier transformation on the data stream, a real part  $X_r(k, t)$  and an imaginary part  $X_i(k, t)$  are obtained, the discrete Fourier transformation device comprising:

a first temporary storage means for storing the data stream  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$  supplied since time  $t$  at time  $t+N-1$  temporarily;

a discrete Fourier operation means for obtaining the complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  of the data stream stored temporarily in the first storage means; and

a second temporary storage means for storing the complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  obtained by the discrete Fourier operation means,

the discrete Fourier operation means including:

a subtracting portion for obtaining a data value of a difference between a data value  $x(t+N)$  supplied at time  $t+N$  and a data value  $x(t)$  memorized temporarily in the first storage means;

a constant multiplying portion for obtaining a signal with a predetermined amplitude by multiplying the obtained data value of the difference with a positive constant value  $A$  for giving a predetermined amplitude;

an adder portion for obtaining a summed signal by summing the signal with the predetermined amplitude obtained from the constant multiplying portion and one of the real part  $X_r(k, t)$  and the imaginary part  $X_i(k, t)$  of the complex Fourier coefficients stored temporarily in the second temporary storage means; and

a basic function arithmetic processing portion for receiving the summed signal obtained from the adder portion and the other of the real part  $X_r(k, t)$  and the imaginary part  $X_i(k, t)$  of the complex Fourier coefficients stored temporarily in the second temporary storage means and carrying out an arithmetic operation on the received signals using a constant based on a basic frequency thereby to obtain the complex Fourier coefficients  $X_r(k, t+1)$  and  $X_i(k, t+1)$  at time  $t+1$ .

2. (Original) A recursive discrete Fourier transformation device as claimed in claim 1 wherein the positive constant value  $A$  for providing with an amplitude corresponding to a difference between the  $x(t+N)$  and the  $x(t)$  is capable of being set selectively with 1, square root of  $N$  or  $1/N$ .

3. (Original) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,  $t+N$  ( $N$  is a positive integer which is 1 or more) each having an equal interval are supplied and as complex Fourier coefficients under degree  $k$  ( $k$  is 0 or a positive integer smaller than  $N$ ) obtained by, with such  $N$  data values supplied since time  $t$  as a data stream, carrying out complex Fourier transformation on the data stream, a real part  $X_r(k, t)$  and an imaginary part  $X_i(k, t)$  are obtained, the discrete Fourier transformation device comprising:

a first temporary storage means for storing the data stream  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$  supplied since time  $t$  at time  $t+N-1$  temporarily;

a discrete Fourier operation means for obtaining the complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  of the data stream stored temporarily in the first storage means; and

a second temporary storage means for storing the complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  obtained by the discrete Fourier operation means,

wherein the discrete Fourier operation means obtains complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  according to following equations.

$$X_r(k, t+1) = \left\{ X_r(k, t) + \frac{1}{A} [x(t+N) - x(t)] \right\} \times \cos \left[ 2 \frac{\pi k}{N} \right] + X_i(k, t) \sin \left[ 2 \frac{\pi k}{N} \right]$$

$$X_i(k, t+1) = X_i(k, t) \cos \left[ 2 \frac{\pi k}{N} \right] - \left\{ X_r(k, t) + \frac{1}{A} [x(t+N) - x(t)] \right\} \sin \left[ 2 \frac{\pi k}{N} \right]$$

where,  $A$  is a positive constant value for providing  $[x(t+N)-x(t)]$  with an amplitude.

4. (Original) A recursive discrete Fourier transformation device as claimed in claim 3 wherein the positive constant value  $A$  for providing with an amplitude corresponding to a difference between the  $x(t+N)$  and the  $x(t)$  is capable of being set selectively with 1, square root of  $N$  or  $1/N$ .

5. (Currently Amended) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,  $t+N$  ( $N$  is a positive integer which is 1 or more) each having an equal interval are supplied and with such  $N$  data values supplied since time  $t$  as a data stream, complex Fourier transformation is carried out to the data stream using a plurality of degrees  $k$  ( $k$  is 0 or a positive integer smaller than  $N$ ) so as

to obtain real parts  $X_r(k, t)$  and imaginary parts  $X_i(k, t)$  as plural sets of complex Fourier coefficients, the discrete Fourier transformation device comprising:

a first temporary storage means for storing the data stream  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$  supplied since time  $t$  at time  $t+N-1$  temporarily;

plural discrete Fourier operation means for obtaining the complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  for the data stream stored temporarily in the first storage means for each of plural  $k$  values; and

a second temporary storage means for storing each set of the complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  obtained by the plural discrete Fourier operation means corresponding to each  $k$  value,

~~the~~ each discrete Fourier operation means including:

a subtracting portion for obtaining a data value of a difference between a data value  $x(t+N)$  supplied at time  $t+N$  and a data value  $x(t)$  memorized temporarily in the first storage means;

a constant multiplying portion for obtaining a signal with a predetermined amplitude by multiplying the data value of the difference obtained by the subtracting portion with a positive constant value  $A$  for giving a predetermined amplitude;

an adder portion for obtaining a summed signal by summing the signal with the predetermined amplitude obtained from the constant multiplying portion and one of a real part  $X_r(k, t)$  and an imaginary part  $(k, t)$  of the complex Fourier coefficients stored temporarily by the second temporary storage means; and

a basic function arithmetic processing portion for receiving the summed signal obtained from the adder portion and the other of the real part  $X_r(k, t)$  and the imaginary part  $(k, t)$  of

the complex Fourier coefficients stored temporarily in the second temporary storage means and carrying out an arithmetic operation on the received signals using a constant based on a basic frequency thereby to obtain complex Fourier coefficients  $X_r(k, t+1)$  and  $X_i(k, t+1)$  at time  $t+1$ .

6. (Original) A recursive discrete Fourier transformation device as claimed in claim 5 wherein the quantity of the degrees  $k$  is  $N$ .

7. (Original) A recursive discrete Fourier transformation device as claimed in claim 5 wherein the positive constant value  $A$  for providing with an amplitude corresponding to a difference between the  $x(t+N)$  and the  $x(t)$  is capable of being set selectively with 1, square root of  $N$  or  $1/N$ .

8. (Currently Amended) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,  $t+N$  ( $N$  is a positive integer which is 1 or more) each having an equal interval are supplied and with such  $N$  data values supplied since time  $t$  as a data stream, complex Fourier transformation is carried out to the data stream using a plurality of degrees  $k$  ( $k$  is 0 or a positive integer smaller than  $N$ ) so as to obtain real parts  $X_r(k, t)$  and imaginary parts  $X_i(k, t)$  as plural sets of complex Fourier coefficients, the discrete Fourier transformation device comprising:

a first temporary storage means for storing the data stream  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$  supplied since time  $t$  at time  $t+N-1$  temporarily;

plural discrete Fourier operation means for obtaining the complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  for the data stream stored temporarily in the first storage means for each of plural  $k$  values; and

a second temporary storage means for storing each set of complex Fourier coefficients  $X_r(k, t)$  and  $X_i(k, t)$  obtained by the plural discrete Fourier operation means corresponding to each  $k$  value,

~~the~~ each discrete Fourier operation means including:

a common subtracting portion for obtaining a data value of a difference between a data value  $x(t+N)$  supplied at time  $t+N$  and a data value  $x(t)$  memorized temporarily in the first storage means;

a common constant multiplying portion for obtaining a signal with a predetermined amplitude by multiplying the data value of the difference obtained by the common subtracting portion with a positive constant value  $A$  for giving a predetermined amplitude;

an adder portion for obtaining a summed signal by summing the signal with the predetermined amplitude obtained from the common constant multiplying portion and one of a real part  $X_r(k, t)$  and an imaginary part  $(k, t)$  of the complex Fourier coefficients stored temporarily in the second temporary storage means; and

a basic function arithmetic processing portion for receiving the summed signal obtained from the adder portion and the other of the real part  $X_r(k, t)$  and the imaginary part  $X_i(k, t)$  of the complex Fourier coefficients stored temporarily in the second temporary storage means and carrying out an arithmetic operation on the received signals using a constant based on a basic frequency thereby to obtain the complex Fourier coefficients  $X_r(k, t+1)$  and  $X_i(k, t+1)$  at time  $t+1$ .

9. (Original) A recursive discrete Fourier transformation device as claimed in claim 8 wherein the quantity of the degrees  $k$  is  $N$ .

10. (Original) A recursive discrete Fourier transformation device as claimed in claim 8 wherein the positive constant value  $A$  for providing with an amplitude corresponding to a difference between the  $x(t+N)$  and the  $x(t)$  is capable of being set selectively with 1, square root of  $N$  or  $1/N$ .

11. (Currently Amended) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,  $t+N$  ( $N$  is a positive integer which is 1 or more) each having an equal interval are supplied and as a complex Fourier coefficient under degree  $k$  ( $k$  is 0 or a positive integer smaller than  $N$ ) obtained by, with such  $N$  data values supplied since time  $t$  as a data stream, carrying out complex Fourier transformation on the data stream, a real part  $X_r(k, t)$  and an imaginary part  $X_i(k, t)$  are obtained, the discrete Fourier transformation device comprising:

a data updating means for obtaining a first subtraction signal by subtracting data  $x(t)$  supplied before  $N$  sampling period from data  $x(t+N)$  supplied at time  $t+N$ ;

a recursive processing means ~~for obtaining a new second subtraction signal by subtracting~~  
including a first subtractor that subtracts an addition signal generated recursively using an already generated second subtraction signal from the obtained first subtraction signal to obtain a new second subtraction signal; and

~~a multiplying means for obtaining the real part  $X_r(k, t)$  of the Fourier coefficients by summing up a signal obtained by multiplying the new second subtraction signal obtained by the recursive~~

~~processing means with a first constant value and a signal obtained by multiplying the second subtraction signal supplied before a sampling period with a second constant value and for obtaining the imaginary part  $X_i(k, t)$  of the Fourier coefficients by multiplying the new second subtraction signal with a third constant value,~~

~~wherein the addition signal generated recursively by the recursive processing means is a signal obtained by summing up a signal obtained by multiplying the second subtraction signal obtained before a sampling period with a fourth constant value and the second subtraction signal obtained before two sampling periods.~~

a multiplying means including a first multiplier that multiplies the new second subtraction signal obtained by the recursive processing means with a first constant value to obtain a first resultant signal, a second multiplier that multiplies the second subtraction signal supplied before a sampling period with a second constant value to obtain a second resultant signal, and a first adder that sums up the first resultant signal and the second resultant signal to obtain the real part  $X_r(k, t)$  of the Fourier coefficients, and including a third multiplier that multiplies the new second subtraction signal with a third constant value to obtain the imaginary part  $X_i(k, t)$  of the Fourier coefficients,

wherein the recursive processing means further includes a fourth multiplier that multiplies the second subtraction signal obtained before a sampling period with a fourth constant value to obtain a third resultant signal, and a second adder that sums up the third resultant signal and the second subtraction signal obtained before two sampling periods.

12. (Currently Amended) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,



$t+N$  ( $N$  is a positive integer which is 1 or more) each having an equal interval are supplied and as a complex Fourier coefficient under degree  $k$  ( $k$  is 0 or a positive integer smaller than  $N$ ) obtained by, with such  $N$  data values supplied since time  $t$  as a data stream, carrying out complex Fourier transformation on the data stream, a real part  $X_r(k, t)$  and an imaginary part  $X_i(k, t)$  are obtained, the discrete Fourier transformation device comprising:

a data updating means for obtaining a first subtraction signal by subtracting data  $x(t)$  supplied before  $N$  sampling period from data  $x(t+N)$  supplied at time  $t+N$ ;

~~a recursive processing means for obtaining a new second subtraction signal by subtracting including a first subtractor that subtracts an addition signal generated recursively using an already generated second subtraction signal from the obtained first subtraction signal to obtain a new second subtraction signal; and~~

~~a multiplying means for obtaining the real part  $X_r(k, t)$  of the Fourier coefficients by summing up a signal obtained by multiplying the new second subtraction signal obtained by the recursive processing means with a first constant value and a signal obtained by multiplying the second subtraction signal supplied before a sampling period with the second constant and for obtaining the imaginary part  $X_i(k, t)$  of the Fourier coefficients by multiplying the new second subtraction signal with a third constant value;~~

a multiplying means including a first multiplier that multiplies the new second subtraction signal obtained by the recursive processing means with a first constant value to obtain a first resultant signal, a second multiplier that multiplies the second subtraction signal supplied before a sampling period with a second constant value to obtain a second resultant signal, and a first adder that sums up the first resultant signal and the second resultant signal to obtain the real part  $X_r(k, t)$  of

the Fourier coefficients, and including a third multiplier that multiplies the new second subtraction signal with a third constant value to obtain the imaginary part  $X_i(k, t)$  of the Fourier coefficients,

wherein a transfer function  $H(Z)$  for the data updating means, the recursive processing means and the multiplying means connected as subsidiary components is given according to a following equation[[.]]:

$$H(z) = A \left( 1 - z^{-N} \right) \left\{ \frac{\cos \left[ 2 \frac{\pi k}{N} \right] - j \sin \left[ 2 \frac{\pi k}{N} \right] - z^{-1}}{1 - 2 \cos \left[ 2 \frac{\pi k}{N} \right] z^{-1} + z^{-2}} \right\}$$

where A is a positive constant value for providing  $[x(t+N)-x(t)]$  with an amplitude.

13. (Original) A recursive discrete Fourier transformation device as claimed in claim 12 wherein the positive constant value A for providing with an amplitude corresponding to a difference between the  $x(t+N)$  and the  $x(t)$  is capable of being set selectively with 1, an inverse number of square root of N or  $1/N$ .

14. (Currently Amended) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,  $t+N$  (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, complex Fourier transformation is carried out to the data stream using a plurality of degrees k (k is 0 or a positive integer smaller than N) so as

to obtain real parts  $X_r(k, t)$  and imaginary parts  $X_i(k, t)$  as plural sets of complex Fourier coefficients, the discrete Fourier transformation device comprising:

plural data updating means corresponding to the plurality of degrees  $k$ , for obtaining a first subtraction signal by subtracting data  $x(t)$  supplied before  $N$  sampling period from data  $x(t+N)$  supplied at time  $t+N$ ;

plural recursive processing means corresponding to the plurality of degrees  $k$ , ~~for obtaining a new second subtraction signal by subtracting~~ each including a first subtractor that subtracts an addition signal generated recursively using an already generated second subtraction signal from the obtained first subtraction signal to obtain a new second subtraction signal; and

~~plural multiplying means corresponding to the plurality of degrees  $k$ , for obtaining a real part  $X_r(k, t)$  of the Fourier coefficients by summing up a signal obtained by multiplying the new second subtraction signal obtained by the recursive processing means with a first constant value and a signal obtained by multiplying the second subtraction signal supplied before a sampling period with the second constant and for obtaining an imaginary part  $X_i(k, t)$  of the Fourier coefficients by multiplying the new second subtraction signal with a third constant value;~~

~~wherein the addition signal generated recursively by each of the plural recursive processing means is a signal obtained by summing up a signal obtained by multiplying the second subtraction signal obtained before a sampling period with a fourth constant value corresponding to each degree  $k$ , and the second subtraction signal obtained before two sampling periods.~~

plural multiplying means corresponding to the plurality of degrees  $k$ , each including a first multiplier that multiplies the new second subtraction signal obtained by each recursive processing means with a first constant value to obtain a first resultant signal, a second multiplier that multiplies

the second subtraction signal supplied before a sampling period with a second constant value to obtain a second resultant signal, and a first adder that sums up the first resultant signal and the second resultant signal to obtain each real part  $X_r(k, t)$  of the Fourier coefficients, and including a third multiplier that multiplies the new second subtraction signal with a third constant value to obtain each imaginary part  $X_i(k, t)$  of the Fourier coefficients,

wherein each recursive processing means further includes a fourth multiplier that multiplies the second subtraction signal obtained before a sampling period with a fourth constant value corresponding to each degree  $k$  to obtain a third resultant signal, and a second adder that sums up the third resultant signal and the second subtraction signal obtained before two sampling periods.

15. (Original) A recursive discrete Fourier transformation device as claimed in claim 14 wherein the quantity of the degrees  $k$  is  $N$ .

16. (Currently Amended) A recursive discrete Fourier transformation device wherein data values  $x(t)$ ,  $x(t+1)$ ,  $x(t+2)$ ,  $x(t+3)$ , ...,  $x(t+N-1)$ ,  $x(t+N)$  sampled at times  $t$ ,  $t+1$ ,  $t+2$ ,  $t+3$ , ...,  $t+N-1$ ,  $t+N$  ( $N$  is a positive integer which is 1 or more) each having an equal interval are supplied, data  $x(t)$  supplied before  $N$  sampling period is subtracted from data  $x(t+N)$  supplied at time  $t+N$  so as to obtain a first subtraction signal, and with such  $N$  data values supplied since time  $t$  as a data stream based on the obtained first subtraction signal, a complex Fourier transformation is carried out to the data stream using a plurality of degrees  $k$  ( $k$  is 0 or a positive integer smaller than  $N$ ) so as to obtain real parts  $X_r(k, t)$  and imaginary parts  $X_i(k, t)$  as plural sets of complex Fourier coefficients, the discrete Fourier transformation device comprising:

plural recursive processing means corresponding to the plurality of degrees  $k$ , ~~for obtaining a new second subtraction signal by subtracting~~ each including a first subtractor that subtracts an addition signal generated recursively using an already generated second subtraction signal from the obtained first subtraction signal to obtain a new second subtraction signal; and

~~plural multiplying means corresponding to the plurality of degrees  $k$ , for obtaining a real part  $X_r(k, t)$  of the Fourier coefficients by summing up a signal obtained by multiplying the new second subtraction signal obtained by the recursive processing means with a first constant value and a signal obtained by multiplying the second subtraction signal supplied before a sampling period with the second constant and for obtaining an imaginary part  $X_i(k, t)$  of the Fourier coefficients by multiplying the new second subtraction signal with a third constant value;~~

~~wherein the addition signal generated recursively by each of the plural recursive processing means is a signal obtained by summing up a signal obtained by multiplying the second subtraction signal obtained before a sampling period with a fourth constant value corresponding to each degree  $k$ , and the second subtraction signal obtained before two sampling periods.~~

plural multiplying means corresponding to the plurality of degrees  $k$ , each including a first multiplier that multiplies the new second subtraction signal obtained by each recursive processing means with a first constant value to obtain a first resultant signal, a second multiplier that multiplies the second subtraction signal supplied before a sampling period with a second constant value to obtain a second resultant signal, and a first adder that sums up the first resultant signal and the second resultant signal to obtain each real part  $X_r(k, t)$  of the Fourier coefficients, and including a third multiplier that multiplies the new second subtraction signal with a third constant value to obtain each imaginary part  $X_i(k, t)$  of the Fourier coefficients.

wherein each recursive processing means further includes a fourth multiplier that multiplies the second subtraction signal obtained before a sampling period with a fourth constant value corresponding to each degree  $k$  to obtain a third resultant signal, and a second adder that sums up the third resultant signal and the second subtraction signal obtained before two sampling periods.

17. (Original) A recursive discrete Fourier transformation device as claimed in claim 16 wherein the quantity of the degrees  $k$  is  $N$ .